12 December 1957

MEMORANDUM FOR: Chairman, GMIC

FROM : R&D Consultant (Germany)

SUBJECT : Moving Target Indicator - Proposed by REG-372

EVALUATION

During the first three months of his employment as deputy to the director (Jun-Aug 57) of the newly organized Institute for High Frequency within the Forschungszentrum der Luftfart (Research Center for Air) located in Dresden-Klotsche, DDR, source worked on the problem of moving target indication. He had had no previous experience in this field. After studying the available literature on German wartime development and early American development, involving the delay line technique, source designed an MTI circuit which, alledgedly, completely eliminates the delay line.

The circuit was registered in the DDR. Source does not know if steps were taken to register the patent in Western countries. Source has decided not to take steps on his own initiative at the present time to register the patent in the west because of possible reprisals against his relatives residing in the DDR.

PROPOSED MTI TECHNIQUE

The purpose of this proposed circuitry is to provide means of identifying moving targets from stationary targets when using radar equipment. The scheme proposed will be suitable for displaying the stationary targets also, should this be desired. In addition, this scheme will permit the selection of only incoming targets, only outgoing targets, or both, outgoing and incoming targets, as desired.

Source states that the proposed MTI scheme eliminates the following items or difficulties normally included in conventional MTI schemes:

a. The delay line element, which is a normally quite costly and critically designed component, is no longer necessary.

b. The critical time correlation of the transmitter pulse repetition frequency and the delay line time constant is eliminated.

c. The blind speeds at which moving targets cannot be detected with conventional MTI systems because of their phase dependency, are eliminated.

58 - 986

Figure one shows one method proposed in this new system. The radar transmitter pulse is used to stabilize a reference frequency generator. During the transmitting pulse the blanker is opened to permit operation of the frequency control circuit. The control is such that the reference frequency generator output is maintained at f which is recovered

Encl #1

T-58 - 1727

where f_1, is the transmitter frequency and f_2 is the local oscillator frequency.

The frequency received will include f_1, the transmitted frequency, and $f_1 + \Delta f$, or $f_1 + \Delta fs$ (more than one moving target). f_1 will be received from all stationary targets which reflect energy back to the receiver; however, moving targets will produce a frequency of $f_1 + \Delta f$. The exact value of Δf, is a function of the radial component of the target speed and the basic transmitter frequency (taking into account glent, reflecting surface, number of hits and jitter). This echo signal is then mixed with the local oscillator frequency, f_2, and the resultant $f_1 - f_2 + \Delta f$ is amplified. The amplified output of this signal is then fed to a multiplier stage of which the output is $4 f_1 - 4 f_2 + 4 \Delta f$. The signal is then mixed with a signal equal to 3 f3 and the resultant frequency obtained is $f_1 - f_2 + 4 \Delta f$. As many multiplication stages and mixers stages can be made as desired (two are shown in Figure One), the output being $f_1 - f_2 + 4^n \Delta f$, where 'n' equals the number of multiplier and mixer stages utilized.

This output is then fed to a discriminator and the output of this stage is fed through opposing diodes, as shown. Depending on which switch, s_1 or s_2, is closed either target moving towards or away from the rader station can be shown on the oscilloscope. If both switches are closed at the same time, all moving targets can be shown.

In the event it is desired to show stationary targets, a parallel branch is connected between the last mixer output passed through a demodulator stage and when s_3 is closed, the stationary targets can be observed. In this branch are included one or more multiplier and mixer stages. The exact number is determined as a function of the lowest speed considered to be a moving target and the pulse wideth of the system. Sufficient number of stages are included so that the multiplication factor obtained places the possible doppler frequencies of moving targets outside of the bandwidth of the last stage. By adding tuned stages just prior to the discriminator stage, one can select targets that are approaching or receding with a given or specific speed.*

*R&D Comment: This scheme is very similar to that used by Raytheon Corp in the Sparrow III system.

58 - 986

NEW CONCEPTS NOT INCLUDED IN DDR PATENT APPLICATION

Figure Two, shows another variation of this over-all MTI scheme. In this case, the discriminator output will be used to control the tuning of the reference frequency generator. If an integrator unit is inserted in the control loop, the loop can be made to compensate for any slow changes in the transmitter frequency and/or the local oscillator.

Another variation of this control scheme Figure Three, is to use again the transmitted pulse and through appropriate attenuation circuitry let each pulse (at a suitable level) be amplified through the circuit. Each transmitter pulse output from the discriminator is used to control the tuning of the reference frequency generator. An appropriate gating scheme, similar to the blanker shown in Figure One will be required to permit the control circuit to be operated only during the time of the transmitter pulse. The circuit control time constants can also be made such that each individual transmitter pulse is used to completely tune the reference signal generator.

COMMENTS

This report does not deal with intelligence aspects of this work which source performed at the research center in Dresden DDR. Nevertheless, the intelligence significance of this proposal as it relates to the guidance system that source worked on in the Leningradskoye shosse Institute in Moscow should be pointed out briefly. The coordinates cabinet designed by source at this institute and which was built there during the period 1951 to mid-1952 for use with the Soviet B-200 guidance system depicted only three dimensions; i.e., two angle and one range dimension. Source had always considered this to be excessively vulnerable and made the comment that if one flying laboratory were to fly past the installation only once it would be possible to detect the weak spots and effectively outmaneuver the installation on a second combat mission.

The MTI technique described above, would, according to source, lend itself quite admirably and easily to the incorporation of a fourth dimension into the coordinates cabinet. With the addition of this fourth dimension, namely speed, the guidance installation would be immeasurably less vulnerable to conventional counter-measures. Indeed, it would be a serious problem then, to combat such guidance installation.

Source was asked whether this idea was:

1. Made known to the Soviets.

2. Indicated to the DDR officials at the time he presented his technique as an MTI proposal.

Source negated both questions. He stated that in the USSR he did not have this idea; and even if he should have had this idea he would not have given expression to it, for fear that the Soviets might decide to hold him in the USSR still longer to work out this improvement on the B-200 installation.

Furthermore, he stated that in the DDR he presented the outlined idea only as an MTI technique and never pointed out its merits in connection with adding a fourth (speed) dimension to a guidance system.

In conclusion, he suggested that while one may well expect the DDR authorities to make the MTI technique available to the Soviets, he does not expect the Soviets to recognize the significance of this MTI technique in connection with the B-200 guidance system. He admitted, of course, that this is purely conjectural.

CONCLUSION

Although it is recognized that similar circuits have been developed in recent years in the USA, there is insufficient information in this office to compare them with the proposed system described herein. It is, therefore, recommended that all interested agencies be requested to evaluate the techniques outlined above. This office requests that any rights of the developer be respected. Source has stated that he is willing for the US Government to utilize the ideas without remuneration; however, if the ideas can be used commercially outside of governmental work, he desires to retain all rights.

This office desires to be informed of the concensus of opinion of these MTI circuits; requests for additional information are solicited.

The information contained in this memorandum will be included in EG-1877 which is scheduled to be published early in 1958.

for C.W. Eifler
Colonel, Ord C

58 - 986

T-58 - 1727

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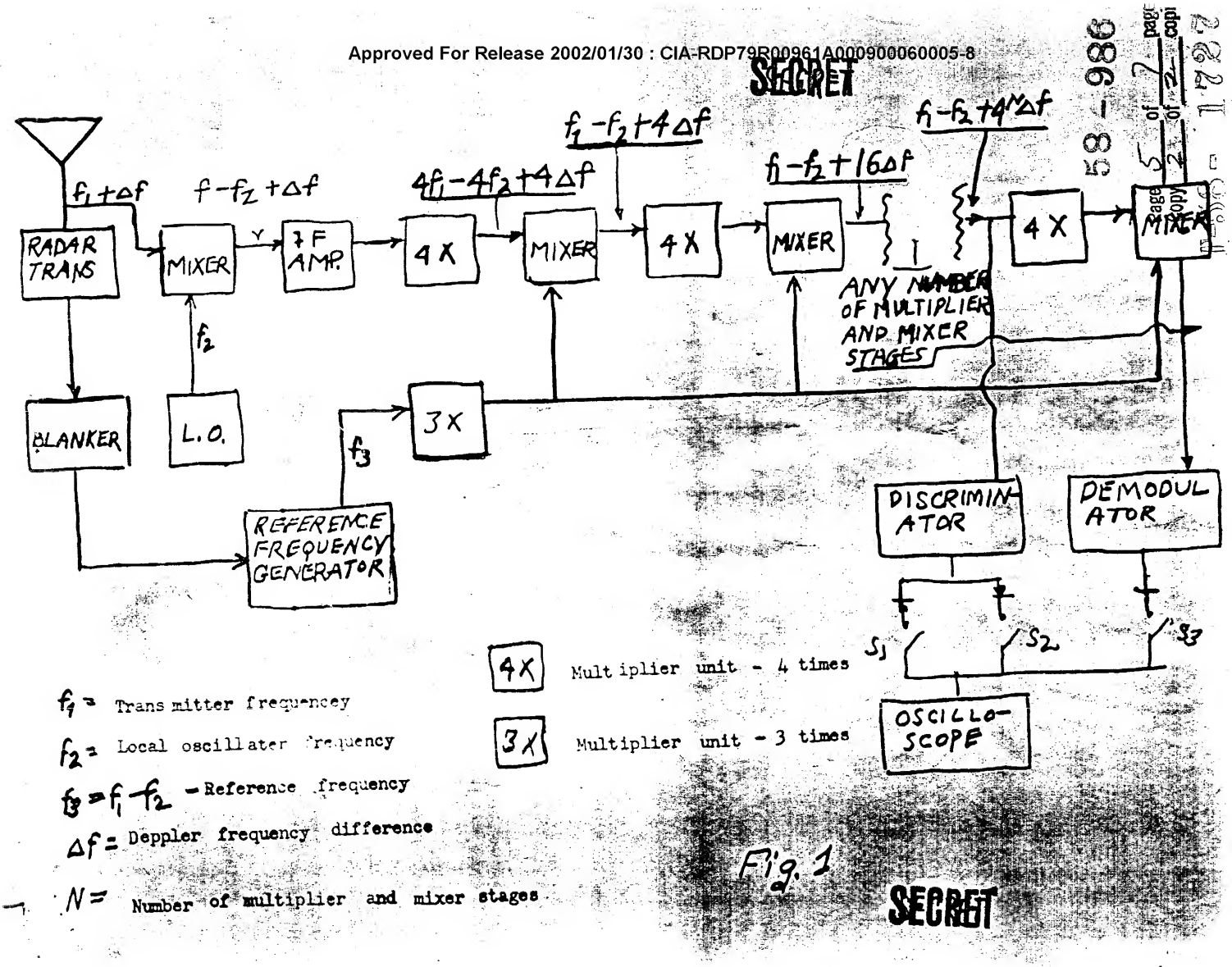

Fig. 1

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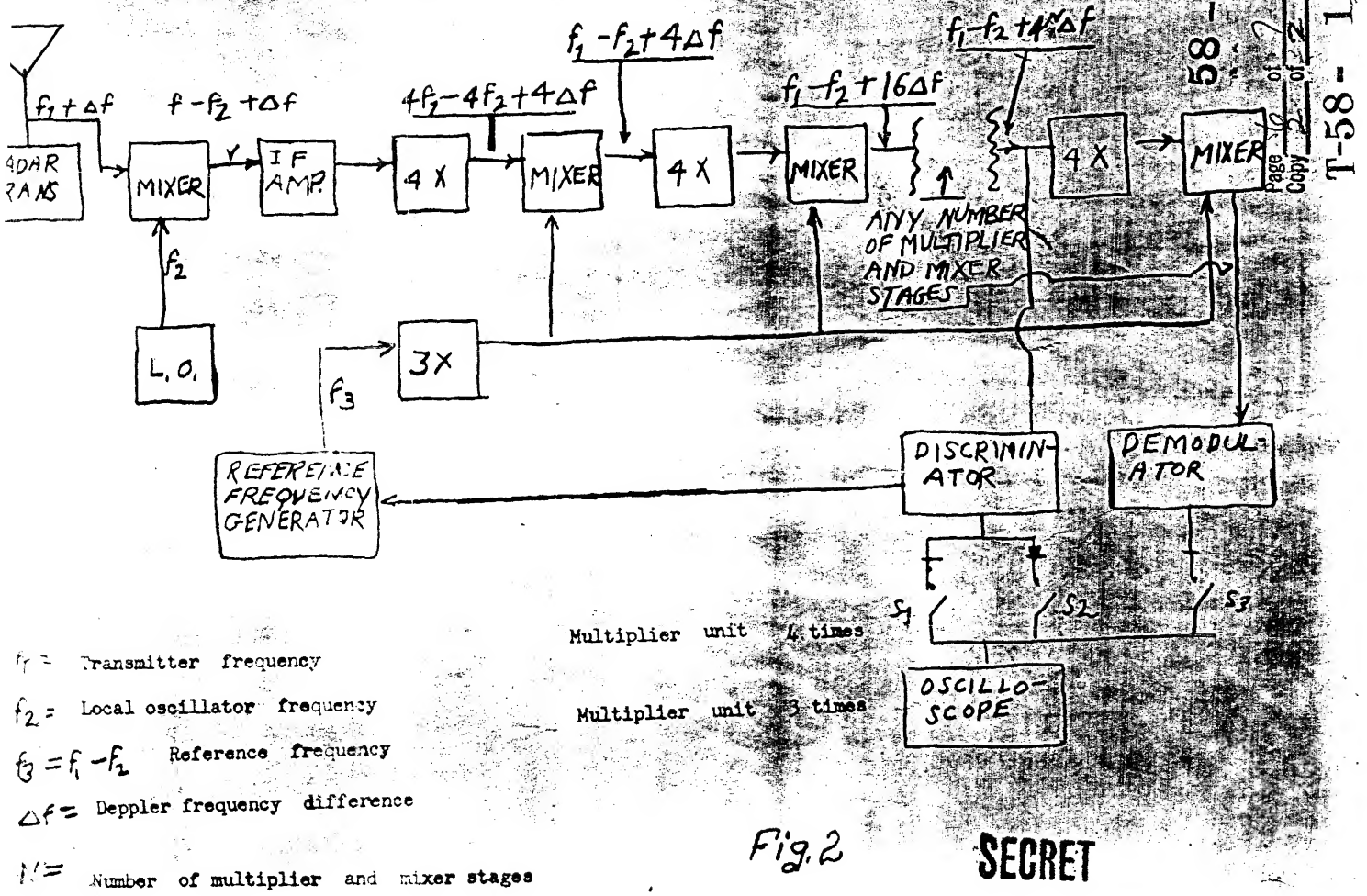

f_1 = Transmitter frequency

f_2 = Local oscillator frequency

$f_3 = f_1 - f_2$ Reference frequency

Δf = Deppler frequency difference

N = Number of multiplier and mixer stages

Fig. 2

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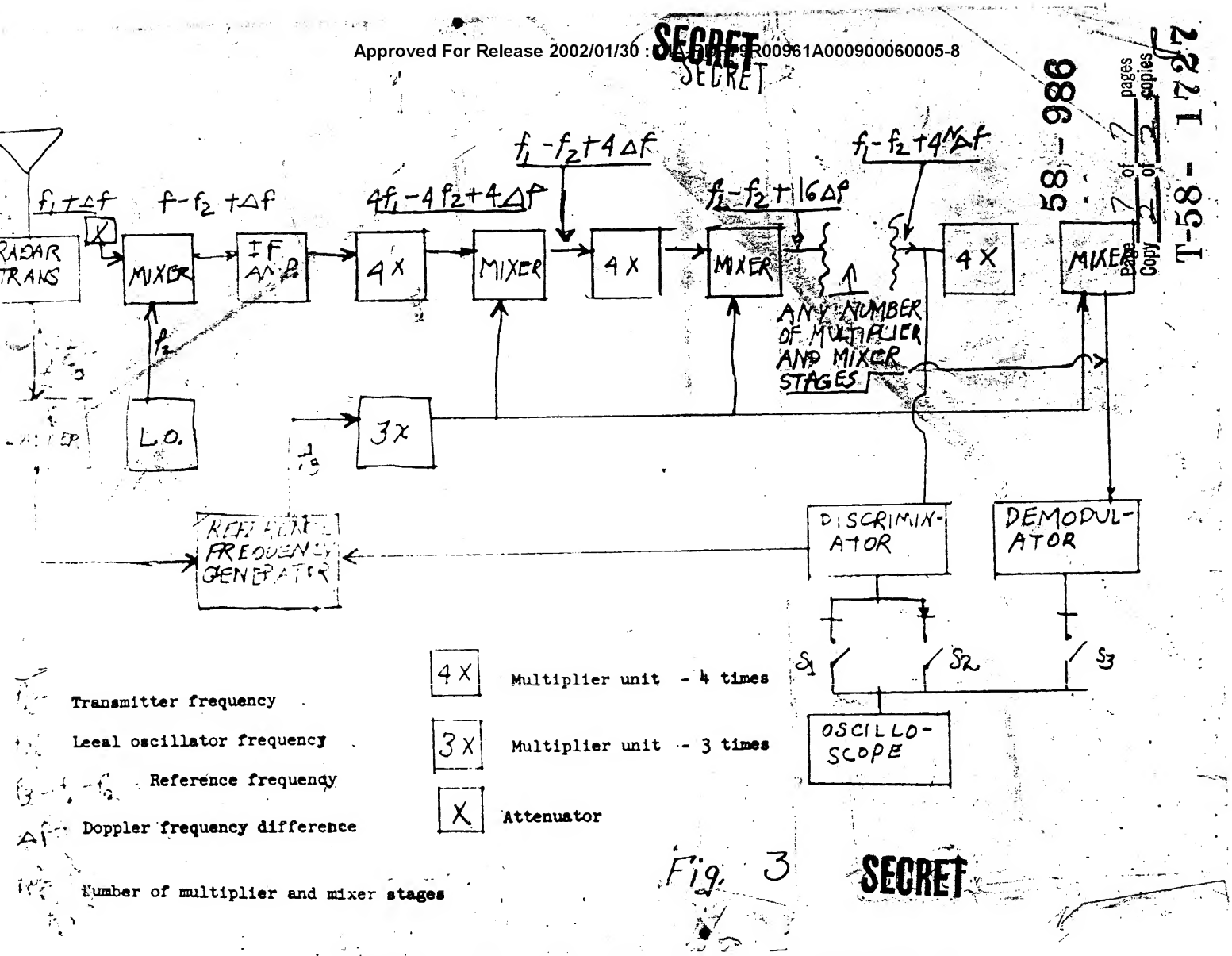

f_1 - Transmitter frequency

f_2 - Leeal oscillator frequency

$f_3 - f_2$ - Reference frequency

Δf - Doppler frequency difference

N - Number of multiplier and mixer stages

4X - Multiplier unit - 4 times

3X - Multiplier unit - 3 times

X - Attenuator

Fig. 3

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